

The effect of anti-oxidant agents as neutralizers of bleaching agents on dentin bond strength

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ABSTRACT

Background: Reduction in bond strength when bonding was done immediately after intracoronal bleaching procedure has been recognized. The purpose of this study is to assess the effect of antioxidants (10% sodium ascorbate (SA), 0.1M thiourea and 7% sodium bicarbonate (SB)) on reversing bonding strength of composite resin to bleached dentin.

Materials and method: Sixty upper 1st premolar teeth, were selected, the crowns of the teeth were embedded in acrylic resin blocks exposing a flat dentin from the buccal surface, then divided into 6 groups (10 samples each). Bleaching for the experimental groups was performed using 35% hydrogen peroxide bleaching gel (pola-office). Group A (Negative control group; dentin samples immediately bonded with composite without bleaching) Group B (Positive control group; dentin samples bleached and immediately bonded with composite). Group C (Dentin samples bleached and stored for 14 days in DDW then bonded with composite). Group D (Dentin samples bleached and treated with 10% (SA) then immediately bonded with composite). Group E (Dentin samples bleached and treated with 0.1M thiourea then immediately bonded with composite). Group F (Dentin samples bleached and treated with 7% SB then immediately bonded with composite). The shear bond strength was determined using instron testing machine.

Results: Bleaching the dentin with 35 % hydrogen peroxide gel for 24 minutes resulted in reduction in bond strength of the bleached teeth when bonding was performed immediately after bleaching. Delayed bonding of composite to the bleached dentin for 14 days will result in a highly significant increase in the shear bond strength.

Conclusion: Treating the bleached dentin with 10% (SA) in water base showed a highly significant increase in the shear bond strength of the composite to dentin and reversing the bond strength value to the level of the unbleached dentin. Treating the bleached dentin with 0.1M thiourea significantly increased the shear bond strength of the composite to dentin.

Key words: Anti-oxidant, sodium ascorbate, thiourea, bleaching agent. (J Bagh Coll Dentistry 2013; 25(2):18-23).

الخلاصة

خلال السنوات الماضية لاحظ الباحثون النقص الحاصل في قوة الربط القصي عن اجراء اللصق الانبي للحنونة الضوئية مباشرة بعد عملية قصر الاسنان داخل التاج 0 الغرض من اجراء هذا البحث هو لتقييم تأثير مواد مضادات التاكسد (10% اسكوربات الصوديوم 0,1 مول ثايورييا و 7% بيكاربونات الصوديوم) على قدرتها على اعادة الربط القصي لمادة الراتنج المركب الى سابق عهدها قبل عملية القصر 0 ولهذا الغرض تم اختيار ستون سن من الضواك وتم قصرها باستخدام بيروكسيد الهيدروجين بتركيز 35% 0 والنتائج اثبتت بعد معالجه عينات العاج المقصورة بمادة 10% اسكوربيدات الصوديوم نتج عنه زيادة عالية في قوة الربط القصي بين مادة الكميوزيت والعاج واعادة قيمة قوة الالتصاق الى مستوى الالتصاق مع العاج الغير مقصور 0 احصائيا لم تكن هناك زيادة ملموسة في قوة الربط القصي بين مادة الكميوزيت والعاج المقصور عند معالجة عينات العاج المقصورة بمادة 7% بيكاربونات الصوديوم 0

INTRODUCTION

Esthetic dentistry is an integral part of any restorative dental practice; one important aspect of esthetic dentistry is bleaching combined with esthetic restorative treatment ⁽¹⁾.

Investigations found that bond strength of composite resin is remarkably reduced when bonding was performed immediately after bleaching procedure ^(2,3).

Various theories have been proposed to explain the effect of bleaching on the bond strength of composite resin to teeth.

Bleaching with hydrogen peroxide may result in significant decrease of enamel and dentin calcium and phosphate content and in morphological alteration in the most superficial enamel crystallites ^(4,5).

Other authors speculated that residual peroxide and/or oxygen radicals in bleached teeth interfere with the polymerization of adhesive restorative material and decrease bond strength ⁽³⁾. Several methods have been proposed to minimize problems related to the reduced bond strength that follows bleaching.

The most common method is to delay any bonding procedure for 2-3 weeks after bleaching ⁽³⁾. The adverse effect of bleaching could also be reduced by treating the bleached surface with alcohol or acetone based adhesive ⁽⁶⁾.

Recently other methods have been used to remove residual peroxide from bleached tooth by using catalase enzyme or using antioxidants to neutralize the effect of oxygen in bleached teeth ⁽⁷⁻¹⁰⁾.

Based on the results of clinical study we can recommend use of antioxidant after endo-bleaching to achieve successful dental fillings in clinical practice ⁽¹¹⁾.

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The aim of this study is to evaluate and compare the effect 35% hydrogen peroxide (pola office) on shear bonding strength of composite to dentin when bonded immediately or delayed to 14 days after bleaching, evaluate and compare the effect of three antioxidants (10% SA, 0.1M thiourea and 7% SB) on shear bonding strength of composite to dentin immediately after the bleaching with 35% H₂O₂.

MATERIALS AND METHODS

Selection and preparation of samples:

Sixty extracted human upper 1st premolar teeth that are extracted for orthodontic purposes cleaned with tap water and a toothbrush and stored in DDW at 4°C until use.

The teeth were examined using a magnifying lens (X10) and transillumination to identify any cracks in the buccal surface of the teeth. The root portions were ground at the level of CEJ with a diamond disk (Meisinger-Germany) in a high – speed hand piece (QD - England) equipped with water spray.

Retention grooves were placed on the proximal surfaces of all the teeth with diamond fissure bur (Swiss TEC-Switzerland) ^(12, 13).

Construction of the acrylic blocks

A metal mold 1.5x1.5cm was fabricated for this study so that the buccal surface of the tooth is out of the acrylic surface to ensure the standardization of the cutting. The metal piece is covered with a dental wax (Poly wax®, modeling wax (BİLİM Chemical Company İZMİR /TURKIYE) and pressed to the buccal surface of the tooth, so the tooth became fixed to it and the self-cure acrylic is added to the mold.

The buccal surface of each tooth was ground flat with Rotofix machine, 2mm in depth using wet 600 - grit silicon carbide abrasive disks ⁽¹³⁾.

The abrasive disks were replaced for every 10 samples. The ground buccal surfaces of dentin specimens were washed with DDW for 30 seconds. The acrylic blocks then stored in DDW for 48 hours at 37°C ⁽¹²⁾.

Sample grouping:

The samples were divided into six experimental groups as shown in table (1)

Bleaching procedure:

The bleaching process was done according to the manufacturer instruction:

A thick layer of gel (pola-office; SDI-Limited), was applied to dentin surface undergoing treatment by brush applicator and leave the gel on the dentin surface for 8 minutes, each sample three times application of Pola Office gel and cured for 30 second using light curing unit (Type; YDL) for each application. After that the Pola-

Office gel was suctioned from the samples by using a surgical aspirator tip (Pola Office manufacture of SDI Dental Esthetic Products Aus. 2007). Then the samples were washed using a continuous jet of DDW /air spray for one minute to dissolve the bleaching agent on the bonding site, and dried with compressed air syringe for 30 seconds ⁽¹²⁾.

Table 1: Samples grouping.

Groups	Type of Samples	Size	Treatments
A	negative control group	10	Dentin samples + ibond + composite (immediately bonded).
B	positive control group	10	Dentin samples + 35% H ₂ O ₂ + ibond + composite (immediately bonded).
C	bleached experimental	10	Dentin samples + 35% H ₂ O ₂ + 14 days delayed + ibond + composite (delayed bonded).
D	bleaching + 10%SA experimental	10	Dentin samples + 35% H ₂ O ₂ + 10% SA + ibond + composite (immediately bonded).
E	bleaching + 0.1M thiourea experimental	10	Dentin samples + 35% H ₂ O ₂ + 0.1M thiourea + ibond + composite (immediately bonded).
F	Bleaching + 7%SB experimental	10	Dentin samples + 35% H ₂ O ₂ + 7% SB + ibond + composite (immediately bonded).

Antioxidants preparation and application:

All the antioxidant agents (10% SA, 0.1M thiourea and 7% SB) were prepared freshly before use and placed in dark plastic containers.

The antioxidants were applied immediately after the bleaching procedure, for 8 minutes (1/3 of the bleaching time) ^(7, 8); using dental brush (one application every 15 seconds) ⁽¹²⁾. The amount of liquid applied to each sample was 0.5ml. This application protocol was used to keep the dentin surface of the sample continuously wet

with antioxidants during the (8 minutes) application time.

Standardization of the washing procedure was done by keeping the air syringe away from the acrylic block that holds the tooth by 1cm for two minutes.

Bonding procedure:

The self-etched one component adhesive, (iBOND® Gluma inside. Germany-HeraeusKulzer) was applied onto the experimental dentin surface area according to the manufacturer instruction using a microbrush applicator and applied in 3 successive layers to the prepared dentin. Following application allow ibond to take effect for 30 seconds then carefully dry with a gentle stream.. Polymerize ibond with a conventional halogen curing light for 20 seconds (23).

Application of composite:

The composite resin (Microfilled- Hybrid composite resin (Ice from SDI-Limited, Shade A1) restoration was applied according to manufacturer instruction; the cylinder (a transparent standardized plastic mold with an internal diameter of 2mm & 3mm in height) was positioned vertically onto the bonding sites was loaded completely with composite resin using a plastic instrument, the vertical position was checked using a rectangular ruler and using a device specially designed for standardization of composite application and curing. (13). The plastic tube and the sticker paper were sectioned carefully with a new surgical blade (NO.22) and removed very carefully. The specimens were stored in DDW for 48 hours at 37°C until testing (12).

Testing:

Shear bond strength was evaluated with Instron testing machine-1122, using a stainless steel chisel -shaped rod with a crosshead speed of 0.5 mm per minute the load cell was set at 100 Kg (14, 22).

Statistical analysis:

Analysis of Variance (ANOVA) test was performed to identify if there is any statistical significant differences among the experimental groups. Paired t-test was used to find any statistical significant differences between each two groups, the probability was highly significant difference at (P<0.001), significant difference at (P<0.05) and no significant difference at (P>0.05).

RESULTS

The mean (SBS) of all the groups are presented in figure (1). It is clear from this bar chart that group A (negative control group) shows

the highest SBS (19.493 MPa) while the group B positive control group (bleached specimens and then immediately bonded with composite without antioxidant) gives the least SBS (9.871 MPa)

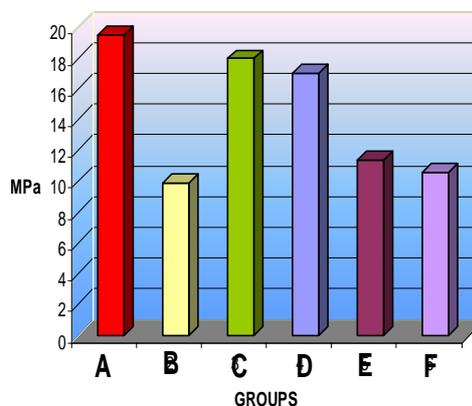


Figure 1: The mean of the shear bond strength values in MPa for each group.

Comparison between all groups:

The statistical analysis of SBS of all the groups using (ANOVA) test showed a highly significant differences (P<0.001) among the groups as shown in table (2).

Table 2: Analysis of variance (ANOVA) of SBS of all the groups.

	Sum of Squares	df	Mean Square	F	Sig
Between Groups	883.364	5	176.673	52.903	.000
Within Groups	180.337	54	3.340		
Total	1063.701	59			

Effect of bleaching on SBS of composite to dentin:

To analyze the influence of the bleaching agent (Pola-office 35% H2O2) on the SBS using t-test the result showed a highly significant difference (P<0.001) between group A (negative control group) and group B; positive control group table (3).

To analyze the influence of time on the SBS the result showed no significant difference in SBS (P>0.05) between group A and group C (bleached specimens and delayed 14 days, storage in DDW at 37°C then bonded with composite) table (3).

Table 3: Comparison between negative control group (A) and other experimental groups using paired t-test.

Groups	Mean	Mean Diff.	t-Test	P-value	
A	19.493	9.622	10.157	0.000	HS
B	9.871				
A	19.493	1.532	1.369	0.204	NS
C	17.961				
A	19.493	2.486	2.121	0.063	NS
D	17.007				
A	19.493	7.964	10.710	0.000	HS
E	11.529				
A	19.493	8.857	8.888	0.000	HS
F	10.636				

The result showed a highly significant difference ($P < 0.001$) between group C and group B; positive control group table (5), when we compare between group C and antioxidants groups (group D, E and F).

The study showed no significant difference ($P > 0.05$) in SBS between group C and group D (bleached specimens then treated with 10% SA and then immediately bonded with composite), and there was a highly significant difference ($P < 0.0001$) in SBS between group C and group E, and between group C and group F (bleached specimens then treated with 7% SB table (5)).

DISCUSSION

It is obvious from the results of this study that highly significant difference ($P < 0.0001$) in SBS between group A and group B. The reduction in bond strength was obvious in spite of short application time of the bleaching gel (24 minutes), and this was noted by many researchers regardless the concentration or the type of the bleaching agents used^(7, 8, 9). This reduction in bond strength could be caused by residual solution in the collagen matrix and dentinal tubules that eventually broke down to oxygen and water, liberation of oxygen could either interfere with resin infiltration into dentinal tubules prevents bonding resin from flowing into the tubules and its presence appears to cause small bubbles to form in the resin which are restricted to the side of tubule orifices, or inhibit polymerization of resins that cure via a free-radical mechanism⁽⁷⁾.

When the specimens were bleached and stored 14 days in DDW then bonded with composite (Group C), this caused a highly significant increase in bond strength value when compared with positive control group B (Table-5), this finding explained that there is a relation between the bond strength and the time of bonding elapsed after bleaching, however, storage in DDW

Table 4: Comparison between group B (positive control group) and antioxidant groups and between antioxidant groups themselves using paired t-test

Groups	Mean	Mean Diff.	t-Test	P-value	
B	9.871	-7.136	8.438	0.000	HS
D	17.007				
B	9.871	-1.658	3.180	0.011	S
E	11.529				
B	9.871	-0.765	1.457	0.179	NS
F	10.636				
D	17.007	5.478	6.879	0.000	HS
E	11.529				
D	17.007	6.371	9.855	0.000	HS
F	10.636				
E	11.529	0.893	1.821	0.102	NS
F	10.636				

Table 5: Comparison between group C and other experimental groups using paired t-test.

Groups	Mean	Mean Diff.	t-Test	P-value	
C	17.961	8.090	11.111	0.000	HS
B	9.871				
C	17.961	0.954	0.969	0.358	NS
D	17.007				
C	17.961	6.432	9.334	0.000	HS
E	11.529				
C	17.961	7.325	10.252	0.000	HS
F	10.636				

did reverse the bond strength to the value of the non bleached teeth group A the result showed no significant difference in SBS ($P > 0.05$) between negative control group (group A) and group C as shown in table (3) and it can be concluded from the findings of the study that no additional waiting period is needed to reverse the bond strength of the bleached teeth to the level of unbleached teeth. These findings could be as a result of leaching of hydrogen peroxide after water storage⁽¹⁵⁾.

When the bleached specimens were treated with 10 % SA in water base (Group D), the result showed a highly significant difference ($P < 0.0001$) in shear bond strength value when compared with positive control group B table (4). The 10% SA can help to neutralize and reverse the oxidizing effects of hydrogen peroxide in biological systems by restoring the altered redox potential of the oxidized bonding substrate, SA allows free-radical polymerization of the adhesive to proceed without premature termination, and hence reverses the compromised bonding in hydrogen peroxide⁽¹⁶⁾.

It has been observed that 10% SA did reverse the bond strength of the bleached dentin to the value of unbleached dentin (negative control

group A) there was no significant difference ($P > 0.05$) in shear bonding strength between group A and group D (Table 3), it is clear from the results of this study that the use of 10% SA before the bonding procedure can reverse the compromised bonding to bleached dentin when the composite bonded immediately and can achieve successful immediate restorative procedure after endo-bleaching and reducing the total time of the complete esthetic treatment.

Also the result showed there was a highly significant difference ($P < 0.0001$) in SBS between group D (treated with 10% SA) and group E (treated with 0.1M thiourea) and also between group D and group F (treated with 7% SB) as shown in table (4), this may be due to ascorbic acid and its sodium salt are potent antioxidants that are capable of quenching reactive free-radicals in biological systems, and can help to neutralize and reverse the oxidizing effects of hydrogen peroxide more than 0.1M thiourea or 7% SB⁽¹⁶⁾.

When bleached dentin treated with 0.1M thiourea then immediately bonded with composite (group E), it was accompanied with an increase in the shear bond strength of the treated dentin and the results showed that, there was a significant difference at ($P < 0.05$) in shear bond strength between positive control group B and group E (Table 4), these may lead to the suggestion that 0.1M thiourea will increase its antioxidant ability to neutralize residual oxygen in bleached dentin, but the results of this study showed that 0.1M thiourea was unable to reverse the bond strength of the treated specimens to the level of negative control group (A) (Table 3), also there was a highly significant difference ($P < 0.0001$) in SBS between group C (bleached and delayed bonding with composite) and group E, as shown in table 5), this could be due to residual crystals of thiourea which was left on the bonding site after washing procedure, these unwashed crystals, which could be seen via stereomicroscope, may adversely interfere with bonding procedure, or higher concentration of thiourea may be needed or increase the application time, or/and these could be due to that 0.1M thiourea less potent as antioxidant than 10%, which may affect the bonding procedure⁽¹⁷⁾.

The treatment of bleached dentin with 7% SB (group F) resulted in a mild increase, non-significant effect on bond strength means compared with positive control group B (Table 4), also there was a highly significant difference ($P < 0.0001$) in SBS between negative control group A and group F and between group C and group F and also between group D and group F.

These effect may be due to that hydrogen peroxide is known to get destabilized and release hydroxyl and perhydroxyl free radicals and oxygen gas in high pH (> 7) environment, thus, the activation of the bleaching gel can be enhanced by raising the pH of the gel by further adding sodium carbonate or SB, to have a large amount of hydroxyl free radicals and hence a large amount of oxygen, that would be released in a very short time and may provide good bleaching action^(10, 18, 19), self-etching primers which contain acidic polymerizable monomers dissolve the smear layer, or incorporate it into the bonding interface, as it demineralizes the surface and engulfs the collagen fibrils and hydroxyl apatite crystals⁽²⁰⁾. 'Mild' self-etch only partially dissolves the dentin surface, so that a substantial amount of hydroxyl apatite remains available within a submicron hybrid layer. The interaction of the etching agents with dentin is limited by the buffering effect of the mineral and organic phases, so that the residual crystals of SB may be neutralizing the acidity of the bonding agent and this affect the formation of hybrid layer and affect the bonding procedure⁽²¹⁾. Under the limitations of this in vitro study, the following conclusion has been drawn:

Bleaching the dentin with 35 % hydrogen peroxide gel for 24 minutes resulted in reduction in bond strength of composite when bonding was performed immediately after bleaching.

Delayed bonding of composite to the bleached dentin for 14 days will result in a highly significant increase in the shear bond strength..

Treating the bleached dentin with 10% SA in water base showed a highly significant increase in the shear bond strength of the composite to dentin and reverses the bond strength value to the level of the unbleached dentin.

Treating the bleached dentin with 0.1M thiourea significantly increased the shear bond strength of the composite to dentin.

There is a non-statistical significant increase in the shear bond strength of the composite to the bleached dentin that is treated with 7% SB.

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